2.0 SYSTEM DESCRIPTION

The bioslurp system consists of fourteen shallow recovery wells, an extraction and treatment trailer, and a 500 gallon product tank.

Major components in the extraction and treatment trailer include:

- A central flow control manifold,
- A liquid vapor separator, or "knockout" drum,
- A liquid ring vacuum pump,
- Two transfer pumps,
- A bag filter,
- An oil water separator,
- Two organoclay filters,
- Two activated carbon filters, and
- System control panel.

During normal operation, a vacuum is applied by the liquid ring pump to one or more of the extraction wells via a central drop tube or "stinger" placed at an elevation near the product/water interface within the extraction well. High air velocity induces the flow of air, diesel and water up the stinger, in a manner similar to that of liquids and air up a straw. The mixed fluids flow from the wells to the extraction and treatment trailer via underground piping. Flow from the individual wells to the trailer can be controlled by opening or closing valves on the intake manifold.

After entering the trailer, the extracted air, diesel and water mixture is directed to a knockout drum. In the knockout drum, the liquids are separated from the vapor stream by gravity. The vapor stream then exits the knockout drum, passes through the liquid ring vacuum pump, and is discharged to the atmosphere.

Diesel and water liquids that collect in the base of the knockout drum are periodically pumped through a bag filter and to an oil water separator. In the oil water separator, the diesel product is separated from the water and directed to the product tank adjacent to the trailer for recovery and recycling. Water from the oil water separator is pumped through two organoclay filter units to remove any residual free phase diesel product and two granular activated carbon filter units to remove any undesirable dissolved phase constituents. After filtration polishing, the water is directed to an NPDES-permitted outfall location.

As-built system drawings are included in the Drawings section on Sheets 1 through 5 and Drawings 03-1061.300 through 03-1061.361. Soil boring logs and well completion reports are included in Appendix A. The system controls are summarized in Appendix B. Manufacturer's information sheets for the primary system components are included in Appendix C. Contact information for the manufacturer/vendor is shown in Table 1.

In addition to the information presented herein, manuals and informational sheets are also available for the minor system components such as valves, flow meters and level controls; power systems; heating and cooling components; and the remote communications system. This information has been assembled in a system manual binder. Copies of the binder are located in the system trailer and at the MFG offices in Boulder, Colorado and Omaha, Nebraska. The binder can also be copied and provided to the Nebraska Department of Environmental Quality (NDEQ) upon request.

2.1 Extraction Wells

The fourteen extraction wells were installed at the locations shown on Sheet 2 in October 2003. Each well was installed to a total depth of 20 feet and completed with 4-inch PVC casing and fifteen feet of 0.01-inch slotted screen, as shown on Sheet 3. The typical depth to groundwater at the time of construction was approximately 13 to 14 feet below ground level (fbgl). However, at the time of system startup, water level elevations increased to approximately 11 to 12 fbgl.

Further well details, including boring logs and completion reports, are included in Appendix A.

2.2 Stingers and Conveyance Pipe

Each well is fitted with a 1-inch PVC stinger. The stinger is connected to a removable pitless adaptor that attaches to the conveyance pipe at approximately 4 feet below the surface. A cross sectional view of the well construction detail is shown on Sheet 3, Trench and Well Details.

Each well is connected to the extraction and treatment trailer manifold by a buried conveyance pipe. The conveyance pipes are constructed of 2-inch, schedule 80 PVC. The pipes are set in trenches to a depth of approximately four feet below ground level for frost protection. Those portions of the conveyance pipes buried

less than four feet are heat traced to guard against freezing. Cross sectional views of the trench details are shown on Sheet 3, Trench and Well Details.

2.3 Extraction and Treatment Trailer

This section describes the major components of the extraction and treatment trailer. These components are housed in a 28 foot long by 8 foot 6 inch wide specially designed trailer. The trailer is mounted on blocks, anchored, and skirted to provide a semi-permanent enclosure for the system. The wheels to the trailer have been removed and placed in the Dahl Building on-site for theft prevention. The trailer has also been grounded with a 10 foot long grounding rod driven vertically to a depth of approximately one foot below ground level.

As discussed further below, the trailer system is equipped with a system control panel with an integrated remote telemetric notification unit that contacts the operator via email of any system alarm conditions. System controls and alarm conditions programmed into the system PLC are described for each component.

2.3.1 Flow Control Manifold

Conveyance pipes from each extraction well enter up through the floor of the trailer to a central flow control manifold. Each leg of the manifold is equipped with a ¼-inch sampling port, a 12-inch long clear sight tube, a vacuum indicator, and a diaphragm valve. The diaphragm valve can be used to control the amount of vacuum applied to each extraction well or close off wells not in use. Each leg of the manifold is plumbed to a common 6-inch diameter PVC header.

2.3.2 Knockout Drum (KOD)

From the control manifold, the header leads to the knockout drum for liquid and vapor separation. The knockout drum is 30-inches in diameter and has a 77 gallon reservoir capacity. The reservoir is located in the lower half of the separator. The upper portion of the separator houses a 40 micron demister pad and 19.7 square feet of polypropylene felt media which provides additional demisting to 4 microns.

The knockout drum is equipped with low, high and high-high level switches for process control. A temperature gauge and vacuum gauge are also installed on the knockout drum. When the high level switch is activated (no delay), transfer pump 1 is turned on to pump liquids from the storage reservoir. Pumping

continues until the fluid level drops below the low level switch. A 30 second delay has been built into the low level switch so that the contents of the lower reservoir below the low level switch will be pumped out before transfer pump 1 is turned off. This feature allows the tank to be fully emptied and prevents the permanent accumulation of floating product on the surface of the knockout tank fluids reservoir. If the high-high level switch is activated for 5 seconds, indicating that fluids are accumulating in the knockout tank reservoir faster than they can be pumped out, the liquid ring vacuum pump is shut down to stop the flow of liquids to the knockout drum, a warning light is illuminated on the control panel and the operator is notified by the remote telemetric unit. The high-high switch automatically resets when the low level switch has been activated for 30 seconds.

2.3.3 Liquid Ring Vacuum Pump (LRP)

A Decker model VMX0453KA1 oil –sealed liquid ring vacuum pump generates the vacuum for the extraction system. The unit is powered by a 25 horsepower pump motor and rated to generate approximately 400 actual cubic feet per minute (acfm) air flow at 20 inches Hg vacuum.

The unit is air cooled and consists of three primary components: the liquid ring pump, the pump motor, and a seal oil separator, which recovers seal oil from the discharging air stream and recycles it back to the pump. Visual read gauges on the unit include an inlet vacuum gauge, a discharge side temperature gauge, and a pressure gauge mounted on the seal oil separator.

Controls on the liquid ring vacuum pump include two inlet side mechanical high vacuum relief valves, an inlet side low vacuum switch, a low oil level switch, a high oil level switch and a high temperature switch. The primary high vacuum relief valve, installed on the inlet piping upstream of the vacuum pump, is set at approximately 24 inches Hg vacuum. A second high vacuum relief valve, mounted on the vacuum pump, is set at 27 inches Hg. Both mechanical vacuum relief valves open to allow ambient air to enter the system if the vacuum in the inlet piping exceeds the set point The low vacuum switch, mounted on the inlet piping to the vacuum pump, turns off the vacuum pump, illuminates a warning light on the control panel and notifies the operator via the remote telemetric unit if the inlet vacuum drops below 5 inches Hg for more than 120 seconds (Note: an extended delay is required for the low vacuum switch to allow the system to achieve the minimum vacuum upon start-up). The low oil, high oil and high temperature switches were installed by the vacuum pump manufacturer and were wired into the system controls by the trailer system vendor. The low and high oil switches are float type switches located within the seal oil separator reservoir. When the low oil switch is activated for 15 seconds, the vacuum pump is stopped, a warning light is illuminated on the control panel, and

the operator is notified. Manual reset of the low oil switch is required. When the high oil switch is activated for 15 seconds, a warning light is illuminated on the control panel and the operator is notified, but the system continues to run. The high temperature switch signals when the oil temperature in the vacuum pump exceeds the set point of 225 deg. F. When this temperature is exceeded for 15 seconds, the vacuum pump is turned off, a warning light is illuminated on the control panel and the operator is notified. The high temperature switch automatically resets after 30 minutes.

2.3.4 Transfer Pump 1 (TP-1)

Transfer pump 1 is a 1.27 horsepower Sepepex progressive cavity pump. This pump transfers fluid from the knockout drum through the bag filter and into the oil water separator. A progressive cavity pump was selected for this application to minimize oil emulsification during pumping and increase the performance of the oil water separator. Under normal operating conditions, transfer pump 1 typically pumps fluids from the knockout tank at a steady rate of approximately 16 gallons per minute.

The pump is controlled by the low and high level float switches in the knockout drum, as described in section 2.3.2. A high temperature switch has been installed on the pump to protect against overheating should the pump run dry for an extended time. When the switch is activated (set point = 131deg. F), the pump is stopped, a warning light is illuminated on the control panel and the operator is notified by the remote telemetric unit. Manual reset of the system is required to clear the alarm condition. The alarm also has a reset delay which prevents the pump from being restarted within approximately 30 minutes of an alarm event.

A pressure gauge and pressure switch are located between transfer pump 1 and the bag filter. The visual read pressure gauge allows the on-site operator to assess the amount of back pressure the bag filter is exerting on transfer pump 1. The pressure switch is set at a pressure of 40 psi. When this pressure is exceeded (no delay), transfer pump 1 is stopped, a warning indicator is illuminated on the control panel, and the operator is notified by the remote telemetric unit. Manual reset of this alarm is required.

2.3.5 Bag Filter

A bag filter is located between transfer pump 1 and the oil water separator to remove suspended solids in solution and protect the coalescing plates in the oil water separator. The bag filter is a stainless steel unit

manufactured by Hayward Industrial Products. It holds a 50 micron filter bag that can be removed and replaced as it accumulates particulates from solution.

The bag filter is also equipped with a drain valve that can be used to empty the unit once it has been isolated from the process by the upstream and downstream ball valves. The drain line is piped along the floor of the trailer and exits by gravity flow through the trailer sidewall. A bucket should be placed under the drain outfall before the bag filter drain is opened.

2.3.6 Oil Water Separator (OWS)

Immediately downstream of the bag filter is an oil water separator that is used to separate the recovered diesel from the recovered groundwater. The oil water separator is a three chamber, stainless steel unit manufactured by Hydro Quip, Inc. The oil water separator is rated for a flow rate of 20 gpm. Oil water mixture enters the 75 gallon inlet compartment of the separator via a submerged drop tube. From the inlet compartment, the product and water mixture overflows into the separation chamber where the mixture flows through 8 cubic feet of coalescing plates designed to separate the oil from the water. Oil rises vertically through the coalescing plates to the top of the separation chamber. An adjustable product skimmer (slotted PVC pipe aligned horizontally across the separation chamber surface) then collects the floating product and discharges it by gravity flow through the side of the oil water separator to the product recovery tank located adjacent to the trailer. A ball valve installed on the gravity flow line can be opened or closed by the operator to allow or prevent flow from the separator to the product tank. Water flows by under flow from the separation chamber into a 73 gallon effluent tank.

The fluid level in the separation chamber is controlled by an adjustable weir set on the effluent side of the separation chamber. The amount of product within the separation chamber is controlled by adjusting the skimmer to the desired depth.

Low, high and high-high level float switches are installed in the effluent tank of the separator unit. When the high level switch is activated (no delay), transfer pump 2 is turned on to pump the water from the effluent tank. Pumping continues until the fluid level drops below the low level switch (no delay) when transfer pump 2 is turned off. If the high-high level switch is activated for 5 seconds, indicating that fluids are accumulating in the effluent tank faster than they can be pumped out, transfer pump 1 is shut down to stop the flow of liquids to the oil water separator, a warning light is illuminated on the control panel and the operator is notified by the remote telemetric unit. The high-high switch automatically resets when the low level switch is activated.

The oil water separator is equipped with drain valves on each of its three chambers so that the separator can be emptied for servicing. The drain lines from each chamber join the drain line from the bag filter and discharge by gravity flow through the side of the trailer. A bucket should be placed under the drain outfall to capture liquids discharging the drain line before emptying of the separator is initiated.

2.3.7 Transfer Pump 2 (TP-2)

Transfer pump 2 is a ½ horsepower, centrifugal pump manufactured by G& L Pumps. It is used to pump water from the effluent tank of the oil water separator through the organoclay and activated carbon filter units. Under normal operating conditions, transfer pump 2 pumps water from the effluent tank at a rate of approximately 20 gallons per minute.

A pressure gauge and pressure switch are located between transfer pump 2 and the organoclay and activated carbon filter units. The visual read pressure gauge allows the on-site operator to assess the amount of back pressure the filter units are exerting on transfer pump 2. Transfer pump 2 can generate a sustained pressure of 11 psi when pumping against a closed pipe. For this reason, the pressure switch is set at a pressure of approximately 10.5 psi. When this pressure is exceeded for 5 seconds, transfer pump 2 is stopped, a warning indicator is illuminated on the control panel, and the operator is notified by the remote telemetric unit. Manual reset of this alarm is required.

2.3.8 Organoclay Filter Units (OC-1 & OC-2)

Two organoclay filter units containing Biomin EC-100 Organoclay are located downstream of the oil water separator to adsorb and remove any diesel product carried over from the separator. Biomin EC-100 Organoclay is organically modified clay that has a high affinity for petroleum hydrocarbons. In filter applications such as this, 8 x 30 mesh size clay granules are blended with anthracite coal of the same size. The organoclay/anthracite blend is housed in a Tetrasolv Model AF-250 filter vessel. Each vessel holds approximately 500 pounds of the EC-100 material.

Each filter vessel is equipped with an inlet pressure gauge and sampling port. The visual read pressure gauges can be used to identify the pressure drop across each unit to identify any potential blockages due to scaling or

fouling of the filter unit. The filter units are mounted on skids and connected by detachable hoses to allow fork lift removal from the trailer (if necessary) for media replacement.

2.3.9 Activated Carbon Filter Units (GAC-1 & GAC-2)

Two filter vessels containing Barnebey & Sutcliffe type 206A (8 x 30 mesh) coal-based activated carbon are located immediately downstream of the organoclay filter units. The primary purpose of carbon units is to remove any dissolved petroleum-related constituents from the water stream.

The activated carbon is housed in Tetrasolv Model AF-250 filter vessels. Each vessel holds approximately 250 pounds of activated carbon. As with the organoclay vessels, each carbon filter vessel is equipped with an inlet pressure gauge and sampling port and mounted on skids to allow removal from the trailer for media replacement.

2.3.10 Liquid Flow Meters/Totalizers (FMT-TP1, FMT-TP2 & FMT-TW)

Three totalizing flow meters are installed in the trailer. One flow meter is located between transfer pump 1 and the bag filter to identify the flow rate and volume pumped by transfer pump 1. Another flow meter is located between transfer pump 2 and the first organoclay filter unit to identify the flow rate and volume pumped by transfer pump 2. The final flow meter is located downstream of the second activated carbon filter unit to identify the flow rate and total volume of treated water produced by the system.

All three totalizing flow meters are Rosemount model 8732C magnetic flow meters. Each unit is configured to provide a visual readout of the instantaneous flow rate in gallons per minute and the cumulative flow total in gallons.

2.3.11 Exhaust Vapor Flow Measurement Device

The flow rate of the exhaust vapor from the liquid ring vacuum pump is continuously measured by means of an orifice plate and differential pressure gauge. The orifice plate and differential pressure gauge are located immediately down stream of the seal oil separator. The differential pressure gauge has been calibrated to directly indicate the vapor flow rate in cubic feet per minute.

2.3.12 Control Panel (CP-1)

The system control panel is mounted on the exterior of the trailer and is accessible by a wooden stair platform. The control panel includes an emergency stop button; selector switches for the liquid ring vacuum pump, transfer pump 1 and transfer pump 2; green run indicator lights; and red warning indicator lights.

The emergency stop button is the large red mushroom head button on the right side of the control panel. When pushed, this button shuts down all power to the trailer and its components. Power can be restored by pulling up on the button. It should be noted that the flow meters will reset themselves whenever power is disrupted. Therefore, the flow totals may be lost if the emergency stop button is depressed.

Hand-off-auto selector switches are provided for the liquid ring vacuum pump and the two transfer pumps. During normal operations, the selector switches are set to "auto". In this mode, the power is provided to the component and all associated control switches are activated, such that the component will shut down as appropriate based on the system control logic. When the selector switch is set to "on", power is provided to the component, but not the associated control switches. This essentially overrides the control switches and allows the component to run regardless of any alarm condition. When the selector switch is set to "off", both the component and the associated control switches are inactivated. All three selector switches are equipped with lockable covers to prevent unauthorized adjustments.

A second control module mounted above and to the right of the control panel contains the remote telemetric unit. In the remote telemetric unit, warning signals generated by the PLC are relayed to the system provider, Telemetric, Inc., via the local wireless cellular network. Telemetric then relays the message to one or more remote operators via email. An internet-based web page can also be used by the remote operator to check on the system operational history or request a real-time status report.

2.3.13 Power

A pole-mounted electric meter and primary breaker are located adjacent to the trailer as shown on Sheet 2. Utility power is delivered to the treatment system via a 200 amp 240 VAC three phase feeder circuit breaker. This power is routed from the feeder breaker to the distribution block, located in control panel CP-1. The feeder circuit breaker is equipped with a shunt trip circuit activated by depressing a locally mounted emergency stop mushroom head push button. Refer to Drawing B-03-1061.601 for further power distribution details.

Low voltage power is derived from a 15 KVA 240 VAC/208 VAC three phase transformer mounted on the trailer tongue. The 240 VAC three phase primary side of the transformer is fed from the power distribution block mounted on control panel CP-1. The 208 VAC three phase (l-l) secondary of the transformer supplies power to the low voltage panel board (LVPB-1). Refer to Drawing No. B-003-1061.601 for further details.

LVPB-1 distributes 208 VAC three phase (L-L) and 120 VAC single phase (L-N) power supplied from the secondary of transformer TX-1. The panel board has a three phase 60 amp feeder breaker. LVBP-1 has a capacity for eighteen single pole circuit breakers. Refer to Drawing No. B-03-1061.602 for details regarding the allocation of circuit breakers in LVPB-1.

2.3.14 System Controls

The extraction and treatment trailer is equipped with PLC-based process controls as described in the preceding sections. A process and instrumentation diagram for the trailer system is shown on Sheet 5, and a summary of the control logic is provided in Appendix B.

2.3.15 Heat Trace System

The trailer is equipped with a low voltage heat trace system that protects the exposed exterior piping from freezing. The following pipes have been heat traced.

- The conveyance pipes leading to the trailer are heat traced from four feet below grade to approximately 6-inches inside the trailer.
- The diesel product line between the oil water separator and the product recovery tank is heat traced from the exterior trailer wall to the top of the diesel tank.
- The treated water discharge pipe is heat traced from the exterior trailer wall to four feet below grade.

The heat trace system is controlled by an automatic temperature sensing thermostat mounted below the control panel. The thermostat has a fixed set point of 40 deg. F. When the ambient temperature falls below 40 deg. F, the thermostat automatically applies power to the heat tracing system. When the ambient temperature rises above 40 deg. F, the heat tracing system is de-energized. Details of the heat trace system are shown on Drawings 03-1061.630 and 03-1061.631.

2.3.16 Ancillary Trailer Systems

In addition to the primary components described above, the extraction and treatment trailer is equipped with interior lighting, an explosion-proof heater, a temperature activated ventilation fan, and a floor sump.

The interior lighting consists of three explosion-proof lights mounted on the trailer ceiling. The lights are activated from a control switch located immediately inside the trailer man door.

An explosion-proof heater is mounted on the front wall of the trailer. A thermostat controller mounted next to the man door is used to set the desired ambient temperature for the trailer. Due to the potential for damage to system components in the event of heater failure, a low temperature switch is located near the rear doors of the trailer. This temperature switch can be set between 40 and 80 degrees F. When the trailer temperature falls below the switch set point for 30 seconds, a warning light on the control panel is illuminated and the operator is notified by the remote telemetric unit. The normal trailer temperature thermostat setting is 50 degrees F., and the normal low temperature alarm set point is 40 degrees F.

A temperature activated ventilation fan is used to cool the trailer. A thermostat controller mounted next to the man door is used to adjust the vent fan set point. When the ambient temperature in the trailer rises above the set point, the ventilation fan is turned on. The normal fan set point is 70 degrees F.

The trailer is equipped with a floor sump located immediately inside the right rear door. The trailer has been leveled to cause any liquids released inside the trailer to flow to the sump. The sump consists of a one cubic foot basin recessed into the floor. The sump is equipped with a high level switch set approximately one inch above its base to detect any liquids accumulating within the sump. When the switch is activated for 5 seconds, the liquid ring vacuum pump is stopped, a warning light on the control panel is illuminated, and the operator is notified by the remote telemetric unit.

2.4 Product Storage Tank (PS)

A 500 gallon product storage tank is located adjacent to the trailer to receive diesel product recovered by the oil water separator. The 4 foot diameter steel tank is positioned horizontally on supports within an integrated steel secondary containment dike. The secondary containment dike is sized to hold 110% of the tank volume. The tank is equipped with a vent, emergency vent, pump out port and level gauge.

High level float switches are located in both the product storage tank and the containment dike. The high level switch in the product tank is positioned approximately 6-inches below the top of the tank. When this switch is activated for 5 seconds, the liquid ring vacuum pump and transfer pump 1 are turned off to stop the flow of liquid to the oil water separator, a warning light is illuminated on the control panel and the operator is notified by the remote telemetric unit. Manual reset of this switch is required.

The high level switch in the secondary containment dike is positioned approximately five inches above the dike floor. When this switch is activated for 5 seconds, the liquid ring vacuum pump and transfer pump 1 are turned off to stop the flow of liquid to the oil water separator, a warning light is illuminated on the control panel and the operator is notified by the remote telemetric unit. Manual reset of this switch is required.

The product storage tank is grounded with a 10 foot long grounding rod driven vertically to a depth of approximately one foot below ground.

2.5 Water Discharge

Water treated in the extraction and treatment trailer is discharged to a buried 4-inch, schedule 80 PVC pipe that extends approximately 550 feet to the southeast before joining a 6-inch PVC pipeline (see Sheet 1). The treated water flows down the 6-inch pipeline approximately 300 feet and discharges to a surface water pond formed by an abandoned oxbow of Elkhorn River. The 6-inch pipe outfall is the site's designated NPDES outfall point. Discharge of treated water associated with petroleum recovery operations is authorized under NPDES permit NEG991003. The permit specifies the discharge limits listed below.

Parameter	Discharge Limit	Monitoring Frequency
Flow	No Limit	Daily
Benzene	0.04 mg/L	Quarterly
Total Xylenes	0.4 mg/L	Quarterly
TRP Oil	10 mg/L	Monthly
pH	6.5 to 9.0	Monthly

Water quality monitoring to confirm compliance with the discharge limitations will be performed as described in Section 3.3.4.

3.0 STANDARD SYSTEM OPERATIONS AND MONITORING

This section describes the standard system operating procedures and associated monitoring activities to be performed.

3.1 Start-up Procedures

The following procedures should be used for initial system start-up or when restarting the system following an extended down period.

Engage Power

1. Switch all three of the selector switches on the control panel ("Hand-Off-Auto") to the "Off" position.
2. Engage all fuses in Control Panel CP-1.
3. Switch all circuit breakers in CP-1 to the "On" position.
4. Switch main 60 amp main feed breaker in LVPB-1 to the "On" position.
5. Switch 200 amp feed breaker to the "On" position (Mounted in alcove next to CP-1).
6. Switch applicable secondary circuit breakers in LVPB-1 to the "On" position.

Prepare System and Test Liquid Ring Vacuum Pump

7. Close all diaphragm valves on the central flow control manifold.
8. Open the 1-inch ball valve located immediately downstream of the knockout drum.
9. Reset all other valves (excluding the valves in steps 7 and 8) to the normal operating positions listed in section 3.2.
10. Confirm that the seal fluid isolation valve in the liquid ring vacuum pump is in the open position (see LRP manual in Appendix C-2 for location).
11. Check the fluid level in the LRP separator reservoir using the sight gauge. Confirm the fluid level is at the "Fill Line". Add oil if necessary.
12. Don hearing protection.
13. Turn the LRP selector switch on the control panel to "Auto" and run the system for a few minutes.
14. Turn the selector switch back to the "Off" position and recheck the fluid level in the LRP separator reservoir. The fluid level should be at the "Fill Line". Add fluid if necessary. **Warning: never remove the oil fill plug while the liquid ring vacuum pump is running.**
15. Turn the LRP selector switch to the "Auto" position. While the LRP is running, check the discharge pressure via the pressure gauge on the seal oil separator. A pressure higher than 5 psi indicates back pressure on the system. If the pressure is greater than 5 psi, change the LRP filter or investigate the discharge piping for any obstructions.
16. After 15 – 30 minutes, check the operating temperature of the LRP via the temperature gauge on the unit. Confirm that the system is operating within the normal temperature range of 140 – 185 degrees F. Consult LRP manual if the operating temperature is above this range.

Begin Drawing Vacuum on Wells

17. Turn TP-1 and TP-2 selector switches to the "Auto" position.
18. Slowly open one or more of the diaphragm valves to the desired wells on the flow control manifold.
19. Close the 1-inch ball valve downstream of the knockout drum, as necessary to maintain the desired vacuum level.
20. Using the diaphragm valves, balance the vacuum levels among the extraction wells and operate as desired. (Note: Depending on seasonal water level elevations, it may not be possible to draw fluids from all wells simultaneously.)

3.2 Normal Operating Conditions

Component	Position
Power Systems	
Main Power Breaker at Electric Meter	On
Circuit Breakers in CP-1	On
60 amp main feeder breaker in LVPB-1	On
200 amp feeder breaker	On
Secondary circuit breakers in LVPB-1	On
Piping Systems	
Sample ports on individual manifold pipes	Closed
Manifold 2-inch diaphragm valves	Operator Selected
1-inch valve between KOD and LRP	Operator Selected
KOD drain valve	Closed
Inlet valve to TP-1	Open
Sample port upstream of TP-1	Closed
½-inch valve between TP-1 and TP-1 flow meter	Closed
Valve between OWS and TP-2	Open
½-inch valve on TP-2	Closed
2-inch throttling valve between TP-2 and OC-1	Operator Selected
2-inch valve immediately upstream of OC-1	Open
2-inch valve between OC-2 and effluent flow meter	Open
½-inch valve downstream of effluent flow meter	Closed
Liquid Ring Vacuum Pump	
Seal Fluid Isolation Valve	Open
Valves on each side of orifice plate	Open
Sampling port downstream of orifice plate	Closed
Bag Filter	
Valves upstream and downstream of Bag Filter	Open
Bag Filter drain valve	Closed
Oil Water Separator	
Oil Skimmer	Operator Selected
Ball Valve on discharge line to product tank	Open
Drain valves on Oil Water Separator	Closed

OC and GAC Filter Units	
Inlet and outlet valves	Open
Sampling ports	Closed
Heating and Cooling Systems	
Heater Thermostat	50 deg. F
Ventilation Fan Thermostat	70 deg. F
Ambient Temperature Alarm	40 deg. F

3.3 System Monitoring

This section describes the routine monitoring activities to be performed during system operation. Appendix D contains log sheets to be used in recording data and other observations during system monitoring.

Results of the inspections will be reported to NDEQ on a quarterly basis.

3.3.1 Wells Fluid Levels

Fluid level will be measured in the six monitoring wells (FP-MW-1 through FP-MW-6) and any recovery wells (FP-BW-series) not undergoing active fluid recovery at the time of monitoring. Fluid level measurements will include depth to product (if present) and depth to water. All measurements shall be relative to the top of the inner PVC well casing on the north side.

Fluid measurements will initially be performed on a weekly basis for the first four weeks of operation and monthly thereafter. Measurement data and any comments will be recorded on the Well Measurements Log Sheet included in Appendix D.

3.3.2 System Trailer Inspections

Inspections of the extraction and treatment trailer system components will be performed on a regular basis to identify any maintenance needs. The inspections will consist of a visual review of the components and monitoring of the system operating parameters, including vacuum levels, pipe pressures, exhaust vapor flow rate, and instantaneous and totalized liquid flows.

Inspections will initially be performed on a weekly basis for the first four weeks of operation and monthly thereafter. Measurement data and any comments will be recorded on the Bioslurp Trailer Log Sheet included in Appendix D.

3.3.3 Product Recovery Tank Measurements

Fluid levels in the product recovery tank will be measured to identify the volume of product and water (if any) recovered by the system. These measurements will be recorded on the Bioslurp Trailer Log Sheet included in Appendix D.

The volume of product and or water in the product recovery tank will be determined based on the depth volume correlations listed on the Horizontal Tank Volume Chart included in Appendix D. This information will be used to identify the diesel and water recovery rates. Arrangements will be made with a third-party product recycler to empty the tanks when the volume recovered approaches 400 gallons (80% of the total tank capacity).

3.3.4 Water Quality Monitoring

Water quality will be monitored at several points along the treatment system flow path to assess the level of treatment provided, identify the need for organoclay and activated carbon media change out, and verify compliance with the site NPDES discharge permit.

Water quality samples will routinely be collected at the following locations for the analyses indicated below.

Sampling Location	**Parameters**
Influent to filter unit OC-1	OA1, OA2
Between filter units OC-1 and OC-2	OA1, OA2
Between filter units GAC-1 and GAC-2	OA1, OA2
Downstream of the final system flow meter	OA1, OA2, pH

These samples will be collected on a weekly basis for the first four weeks of operation and monthly thereafter.

3.3.5 Exhaust Vapor Monitoring

The liquid ring vacuum pump exhaust vapor will be monitored in accordance with the NDEQ Air Emissions Guidance for Petroleum Remedial Sites. Vapor samples will be collected from the sampling port located immediately downstream of the flow measurement orifice plate. The samples will be obtained by drawing the vapor through a prepared charcoal tube at a regulated flow rate until a total volume of 30 liters has been sampled.

Sampling and analysis will be performed in accordance with NIOSH Method 1501. Because the site involves diesel product recovery, the samples will be analyzed for benzene only, as specified in the guidance.

Vapor monitoring will be performed approximately 12 hours after start up, after one week of operation; after two weeks of operation; and at the one, two, three, four, five, six and twelve month inspections. The need for monitoring beyond twelve months will be determined based on initial sampling results.

4.0 STANDARD MAINTENANCE

This section summarizes the standard maintenance requirements for each system component. Further details of the required maintenance functions are described in the manufacturer's product information sheets contained in Appendix C.

4.1 Extraction Wells

No routine maintenance is required for the extraction wells. Wellheads damaged by vehicle traffic shall be repaired or replaced as soon as practicable.

4.2 Stingers and Conveyance Pipe

The inlet elevation of the stinger tubes may need to be periodically adjusted to compensate for product and groundwater level fluctuations in the wells and surrounding aquifer material. Each stinger has a hard pipe stem with a threaded lower end. Additional sections of various lengths may be threaded onto the lower end or removed, as necessary.

The stingers can be removed from each well by unthreading the PVC positioning rod, threading on a five foot long by 1-inch diameter steel pipe, and uncoupling the stinger from the pitless adapter by lifting vertically upward. Care should be taken to not bend and break the stingers during removal.

4.3 Extraction and Treatment Trailer

Routine maintenance activities for the components in the extraction and treatment trailer are described below.

4.3.1 Flow Control Manifold

No routine maintenance is required for the manifold components. Should a vacuum gauge malfunction, it should be removed and replaced with new gauge.

4.3.2 Knockout Drum (KOD)

The knockout drum contains a polypropylene felt filter that may become fouled with particulates over time. No guidelines are given by the manufacturer regarding the vacuum drop at which replacement is recommended. Therefore, it will be necessary to monitor the differential between the vacuum gauge on the liquid ring vacuum pump and the vacuum gauge on the knockout tank. When the vacuum drop begins to interfere with product recovery, the filter should be changed. Procedures for replacing the filter are identified in Appendix C-1

4.3.3 Liquid Ring Vacuum Pump (LRP)

Routine maintenance is specified by the liquid ring vacuum pump at the following intervals:

500 hours (21 days)

- Check oil level
- Check inlet filter
- Clean seal fluid strainers
- Check for water in sight gauge (drain if necessary)
- Check piping for oil leakage and tighten if necessary

1,000 hours (42 days)

- Check back pressure on separator element (if >4 psi, replace filter and check discharge piping for blockage)
- Clean or replace inlet filter element every 1,000 hours or if excessive pressure drop is noticed
- Remove any debris from pump housing, motor fan guard and heat exchanger

1,000 – 3,000 hours (42 – 125 days)

- Grease bearings (see manufacturer information sheet, page 12 for grease type and procedure)

Annually

- Change seal fluid with manufacturer's seal fluid

30,000 hours (3.4 years)

- Have factory trained technician replace the pumps mechanical seals and bearings

See manufacturer's information sheets in Appendix C-2 for procedures and/or further information.

4.3.4 Transfer Pump 1 (TP-1)

Transfer pump 1 consists of the progressive cavity pump, gearbox and motor. The pump is self lubricating and no routine maintenance is required. Seals on the pump should be replaced if they are observed to be leaking.

Routine maintenance on the gearbox consists of changing the mineral lubricant every 10,000 hours of operation (or approximately every 4.5 years, assuming TP-1 runs approximately one quarter of the time). Lubricant specifications and replacement procedures are described in the gearbox information contained in Appendix C-3.

Bearing used in the motor are shielded and greased in the factory. No maintenance is required for them. Routine maintenance on the motor consists of inspecting the motor approximately every three months. The inspections should include the following actions.

- Visually confirm that the motor is clean and free of debris that could block motor ventilation.
- Use a Megger to check the integrity of the winding insulation. Record the readings and immediately investigate any significant drop in insulation resistance.
- Check electrical connections to confirm that they are tight.

4.3.5 Bag Filter

Periodic replacement of the filter bag is the only required maintenance for the bag filter. The filter manufacturer recommends changing the filter bag at a differential pressure of 20 psi. Since there is essentially no back pressure on the bag filter, a pressure reading of 20 psi at the visual pressure gauge immediately downstream of TP-1 should be used as the benchmark for bag change out. Procedures for changing the filter bag are identified in the manufacturer's information in Appendix C-4.

4.3.6 Oil Water Separator (OWS)

Routine maintenance of the oil water separator consists of inspecting the unit to assess if excessive solids or debris have accumulated in the separator to the point of plugging the lower portion of the coalescing plates. To gauge the rate of solids accumulation, drain and inspect the separator chambers after approximately 6 months operation to identify the solids accumulation rate. Use this rate to determine the timing of the next cleaning

activity in order to keep the solids level below the coalescing plates. Procedures for draining the separator and cleaning the coalescing plates are identified in the manufacturer's information in Appendix C-5.

4.3.7 Transfer Pump 2 (TP-2)

Transfer pump 2 consists of the pump and motor. The motor and pump are an integrated unit for which no maintenance is required.

4.3.8 Organoclay Filter Units (OC-1 & OC-2)

The primary maintenance function associated with the organoclay filter units is the periodic replacement of the filter media once its retention capacity for free phase hydrocarbons has been exhausted. Data from the startup testing and early operation monitoring in conjunction with media capacity data from the manufacturer will be used to establish a change out schedule for the filters.

The filters should be operated in an upstream or countercurrent fashion in order to maximize the media life. This means that when the lead (upstream) filter capacity has been exhausted, the filter media should be replaced. The second filter should then be moved into the lead position and the replenished filter should be installed in the second position. This method of operation allows each filter to reach full saturation prior to replacement. The spent organoclay should be sampled to support identification of suitable disposal options and disposed in accordance with state regulations. Procedures for the removal and replacement of the spent media are described in Appendix C-7.

Note that the organoclay media must be pre-wetted and de-aerated prior to use. Procedures for wetting and de-aerating the media are also provided on a separate page in Appendix C-7.

4.3.9 Activated Carbon Filter Units (GAC-1 & GAC-2)

Maintenance requirements for the carbon filters are identical to the maintenance requirements for the organoclay filters. However, the media change out cycle will be different. Data from the startup testing and early operation monitoring will be used in conjunction with media capacity data from the manufacturer to identify when the carbon's capacity will likely be exhausted. This information will be used to establish a change out schedule for the filters.

The carbon filters must also be pre-wetted and de-aerated as specified in Appendix C-7 prior to use.

4.3.10 Liquid Flow Meters/Totalizers (FMT-TP1, FMT-TP2 & FMT-TW)

No routine maintenance activities are required for the liquid flow meters/totalizers.

4.3.11 Exhaust Vapor Flow Measurement Device

No routine maintenance activities are required for the orifice plate or differential pressure gauge.

4.3.12 Control Panel (CP-1)

No routine maintenance is required for the control panel. However, the control panel is equipped with a small panel heater to keep the panel components functioning properly. The temperature setting on the panel should be set at approximately 50 deg. F, and the heater operation should be checked each fall before the onset of cold weather.

4.3.13 Power

No routine maintenance activities are required for the power system.

4.3.14 System Controls

The system controls should be tested for proper operation annually and before restarting the system after any extended down periods.

4.3.15 Ancillary Trailer Systems

Bulb replacement is the only routine maintenance function for the interior lighting system.

Routine maintenance for the explosion proof heater consists of annual inspections to ensure all terminal connections are tight and in good condition. The explosion proof conduits should also be inspected for any visible damage and tightness. If reduced heat output is suspected, the mechanical checks specified in the manufacturer's information in tab section 21 of the manuals binder (located in the trailer) should be performed.

Routine maintenance activities required for the thermostat and ventilation fan include checking the thermostat and fan for proper operation each spring before the onset of 70 deg. F temperatures, and periodically inspecting the fan to confirm the fan guard is free of debris, wasp nests, rodent nests, etc.

In addition to the annual testing of the floor sump switch specified under section 4.3.14, the sump should be periodically inspected for the accumulation of liquids, dirt and debris. If any of these materials are present, they should be removed.

Table 1
Equipment Manufacturers, Vendors & Site Contacts

Initial System Design Engineers
Cameron-Cole, LLC
5777 Central Avenue, Ste 100
Boulder, CO 80301
Phone (303) 938-5500
Fax (303) 938-5520

Final Design and Construction Managers
MFG, Inc.
9910 48th Street, Ste 200
Omaha, NE 68152
Phone (402) 933-1345
Fax (402) 933-1346

Remediation General Contractor
Phillip Environmental Service Corporation
210 West Sand Bank Road
Columbia, IL 62236
Phone (618) 281-7173
Fax (618) 281-5120

Remediation Trailer Vendor
GMG Corporation
600 Hunt Valley Circle
New Kensington, PA 15068
Phone (724) 334-7740
Fax (724) 334-7744

Electrical Subcontractor
Model Electric
1506 N. 1st Street
Norfolk, NE 68701
Phone (402) 371-7711
Fax (402) 371-0742

UPRR Main Point of Contact
Jeff McDermott
Environmental Manager
1416 Dodge Street, Room 930
Omaha, NE 68719
Phone (402) 271-3675
Fax (402) 271-4461

Nebraska Central Railroad Primary Point of Contact
Ted Rydel
Phone (402) 750-4086
Mobile (402) 750-2271

Nebraska Central Railroad Yard Point of Contact
Todd McKee
Phone (402) 750-4089

Fire Marshall
Terry Zwiebel
Norfolk Fire Division
701 Koenigstein
Norfolk, NE 68701
Phone (402) 844-2061
Fax (402) 644-8748